# 1999 SURFACE WATER AND GROUNDWATER MONITORING REPORT NEW WORLD MINING DISTRICT RESPONSE AND RESTORATION PROJECT

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February 11, 2000

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# 1.0 INTRODUCTION

This document presents surface water and groundwater data collected during the 1999 calendar year in conjunction with response and restoration activities at the New World Mining District. To avoid redundancy, only generalized descriptions of the site, the study objectives, and the organization of the project are provided herein. The reader is encouraged to review the *Overall Project Work Plan* (Maxim, 1999a) to gain a better understanding of these aspects of the project.

### 1.1 PROJECT BACKGROUND

The New World Mining District (District), which includes a mixture of National Forest Service and private lands, is a historic metals mining district located in the general vicinity of Cooke City, Montana in the Beartooth Mountains. This historic mining district, which is centered about four miles northeast of the northeast gate to Yellowstone National Park, contains hard rock mining wastes and acid discharges that impact the environment. Human health and environmental issues are related to elevated levels of heavy metals present in mine waste piles, open pits, acidic water discharging from mine openings, and stream sediments.

On August 12, 1996, the United States signed a Settlement Agreement (Agreement) with Crown Butte Mining, Inc. (CBMI) to purchase CBMI's interest in their District holdings. The resulting transfer of property to the U.S. government effectively ended CBMI's proposed mine development plans and provided \$22.5 million to cleanup historic mining impacts to specific properties in the District. In June 1998, a Consent Decree (Decree) was signed by all interested parties and CBMI, and approved by the United States District Court, that finalized the terms of the Agreement and made available the funds that will be used for mine cleanup.

The USDA-FS, as the lead agency responsible for implementing the cleanup of the District, has assembled an organization and guiding objectives to proceed with response actions and restoration of the historic mining impacts in the District. Under their Superfund authority, the USDA-FS will conduct the response and restoration project by following guidance provided by the EPA for Non-Time-Critical Removal Actions. As part of response and restoration activities, long-term surface water and groundwater monitoring is being conducted in the District.

### 1.2 PURPOSE

The primary purpose of monitoring surface water and groundwater during 1999 was to collect data to develop a means with which to document improvement in water quality and erosion control that result from response and restoration actions. Additionally, surface water quality monitoring was conducted in the District in order to: 1) Comply with the requirements of the rule adopting temporary water quality standards for segments of Daisy Creek, the Stillwater River, and Fisher Creek in accordance with the Montana Water Quality Act (§ 75-5-201 et seq.), and 2) Monitor the effects on surface water quality and flow resulting from remediation and removal actions being conducted on mine related disturbances in watersheds within the District.

### 1.3 SITE LOCATION AND DESCRIPTION

The New World Mining District (District) is located in Park County in south central Montana. The District is bounded on the south by the Montana-Wyoming state line, on the west by Yellowstone National Park and on the north and east by the Absaroka-Beartooth Wilderness area boundary (Figure 1). The District is characteristic of subalpine regions of the northern Rocky Mountains with elevations that range from approximately 2,400 meters (7,900 feet) to over 7,900 meters (10,400 feet). Accumulated snow pack in the higher elevations range from 3 meters (10 feet) to over 6 meters (20 feet) deep where drifting occurs. The ground is generally snow covered from late October through mid May at the lower elevations and from early October through late July at the higher elevations. Perennial and semi-perennial snowfields occupy the north facing slopes of the highest mountain peaks.

Area streams are high energy, first and second order tributaries of the Yellowstone River system. These streams occupy glacially carved valleys and are fed largely by melting snow pack. Peak streamflow is characteristically reached by mid June or early July and may be several orders of magnitude higher than baseflow conditions, which typically occur in late winter or early spring. Three drainage basins have been identified as potentially being impacted by the proposed response and restoration actions: 1) Fisher Creek and the Clarks Fork of the Yellowstone River; 2) Daisy Creek and the Stillwater River drainage basin; and, 3) Miller Creek and Soda Butte Creek drainage basin.

The communities of Cooke City and Silver Gate, Montana, are the only population centers near the District. The neighboring communities of Mammoth, Wyoming and Gardiner, Montana are located about 50 miles to the west. Red Lodge, Montana is located about 65 miles to the northeast, via the Beartooth Highway, and Cody, Wyoming is located 60 miles to the southeast.

As the District is located at an elevation that ranges from 7,900 feet to over 10,400 feet above sea level, the site is snow-covered for much of the year. Only two routes of travel are open on a year-round basis to the District: the Sunlight Basin road, which allows access to within a few miles of the District in the wintertime; and the highway between Mammoth and Cooke City. The Beartooth Highway is closed during the winter, as is Highway 212 from Cooke City to the Montana/Wyoming state line.

The District covers an area of about 100 square kilometers (40 square miles). Historic mining disturbances affect about 20 hectares (50 acres). The McLaren Tailings, located outside District Property, covers an additional 4.34 hectares (11 acres). Topography of the District is mountainous, with dominant glacial features. The stream valleys are U-shaped and broad while the ridges are steep, rock covered, and narrow. Much of the District is located at or near tree line, especially in the Fisher Mountain area where the major mining disturbances are located.

The district is situated at the headwaters of three river systems, which all eventually flow into the Yellowstone River. The three tributary rivers are the Clark's Fork of the Yellowstone, the Stillwater River and Soda Butte Creek (Figure 1).

Figure 1 - Project Vicinity Map

Figure 1. Back page

# 2.0 METHODS

Surface water and groundwater monitoring actitities were conducted in general accordance with the 1999 Work Plan (Maxim, 1999b) and the Site-Wide Sampling Analysis Plan (Site-Wide SAP) (Maxim 1999c). More detailed descriptions of our methods can be found in these plans. A summary of the methods used is provided in this section.

# 2.1 Surface Water Monitoring

All surface water samples were collected and analyzed according to procedures described in the *Long-Term Surface Water Quality Monitoring Plan* (Maxim 1999d). Surface water samples were collected for three events in May, July, and September 1999. Water samples were collected at pre-established monitoring stations (Maxim 1999d). Sample locations in each of the three watersheds are listed in Table 1 and shown on Figure 2. Sampling occurred at or near low flow conditions (May), at or near high flow conditions (July), and at the end of the construction season (September). All surface water samples were submitted to Northern Analytical Laboratories, Inc. in Billings, Montana for analysis of parameters listed in the Site-Wide SAP. Discharge measurements and sample notes were taken at all surface water monitoring stations immediately prior to collecting samples.

### 2.1.1 Deviations from 1999 Work Plan

Two surface water stations, SBC-2 and RR-SBSW-102 were not sampled in 1999 because they were added to the final Long-Term Monitoring Plan in November 1999. Additionally, Station SW-2 was added to the final work plan in September 1999 in order obtain monitoring data in Miller Creek drainage because monitoring station SW-5 was dry during the May and September sampling events.

### 2.2 Groundwater Monitoring

Two groundwater monitoring events were completed in the District during 1999. The first event was conducted in May when water levels are typically at or near seasonal lows. The second event was completed in July when water levels are typically at seasonal highs. Monitoring activities included groundwater sampling, laboratory analysis, and water level measurement. Table 2 lists monitoring wells sampled during 1999 and Figure 3 shows locations of these wells.

Water samples were collected from monitoring wells using methods and procedures described in the Site-Wide SAP (Maxim, 1999c). All groundwater samples were submitted to Northern Analytical Laboratories in Billings, Montana for analysis of parameters listed in the Site-Wide SAP. Water levels were measured in each well immediately prior to purging the wells. Dye samples were collected from all wells and several adit discharges for fluorescent dye analysis. The purpose of the dye sampling was to follow up on a tracer study where dye was injected in the McLaren Pit area during August 1997 and May 1998 by the EPA. Dye samples were shipped to Cambrian Ground Water Company in Oak Ridge, Tennessee for analysis. Fluorescent dye results will be presented in a separate report.

### 2.2.1 Deviation from 1999 Work Plan

All monitoring wells were sampled during the July sampling event. Due to snow conditions that made the wells inaccessible, eleven monitoring wells were not sampled during the May sampling event. Table 2 indicates the wells that were inaccessible.

During the May sampling event, wells EPA-4, EPA-5, EPA-7, EPA-11, and MW-11 were not sampled because these wells were either dry or failed to recharge after well purging. Well EPA-7 was the only well that was dry during the July event. Well MW-10 was sampled in July in place of Well MW-10B.

	TABLE 1 1999 SURFACE WATER SAMPLE SITES New World Mining District – Response and Restoration Project												
Site Name	Location	May	July	September									
	Clarks Fork Drainage												
SW-6	Clarks Fork Yellowstone River at Saw Mill Road Crossing	✓	1	1									
Daisy Creek Drainage													
DC-2	Daisy Creek Below Confluence of McLaren Tributaries	✓	1	✓									
DC-5	Daisy Creek Above Confluence with Stillwater River (DNRC- 127)	✓	1	1									
SW-7	Stillwater River at Stillwater Trail Crossing	✓	1	✓									
	Fisher	Creek Drainage											
CFY-2	Fisher Creek Above Confluence with Clarks Fork Y.	✓	✓	✓									
SW-3	Fisher Creek at DNRC Gauging Station (DNRC-207)	✓	1	✓									
SW-4	Fisher Creek at Lulu Road Crossing	✓	1	<b>✓</b>									
	Miller	Creek Drainage											
SW-2	Miller Creek below Miller Mountain Road crossing	Replace	ed SW-5	✓									
	Soda But	te Creek Drainage											
SBC-1	Soda Butte Creek above confluence with Miller Creek	✓	1	1									
SBC-2	Soda Butte Creek below McLaren Tailings	Added to work	z plan after September sa	ampling event									
SBC-4	Soda Butte Creek at Yellowstone Park Boundary	✓	✓	✓									
RR-SBSW-102	Soda Butte Creek below confluence with Republic Creek	Added to work	c plan after September sa	ampling event									

Note: Well locations shown on Figure 2.

√ - sampled

Figure 2

Figure 2 Back page.

Figure 3

Figure 3 Back page

TABLE 2
1999 GROUNDWATER SAMPLE SITES
New World Mining District - Response and Restoration Project

Well	Year	May	July	Completion							
No.	Installed			Formation							
			McLar	en Pit Area							
EPA-1	1996	✓	✓	Wolsey Shale							
EPA-2	1996		✓	Fisher Mtn. Intrusive/Wolsey Shale							
EPA-3	1996		✓	Waste Rock							
EPA-4	1996	Dry	✓	Waste Rock							
EPA-5	1996	Dry	✓	Fisher Mtn. Instrusive							
EPA-6	1996	✓	1	Fisher Mtn. Instrusive							
EPA-7	1996	Dry	Dry	Waste Rock							
EPA-8	1996	✓	✓	Meagher Limestone							
EPA-9	1996	✓	✓	Wolsey Shale							
EPA-10	1996	✓	✓	Meagher Limestone							
MW-2	1989	✓	✓	Wolsey Shale							
Tracer-2	1997		1	Fisher Mtn. Instrusive							
			Como	Basin Area							
EPA-11	1996	Dry	✓	Tertiary Intrusive Dike							
EPA-12	1996	✓	1	Scotch Bonnet Diorite							
MW-1	1989	✓	1	Wolsey Shale							
MW-8	1989	✓	1	Lulu Pass Rhyodacite							
Tracer-4	1997		1	Fisher Mtn. Instrusive							
Tracer-6	1997		1	Scotch Bonnet Diorite							
			Fisher	Creek Area							
MW-9A	1990		✓	Alluvium							
MW-9B	1990		1	Precambrian							
MW-10A	1990	✓	1	Alluvium							
MW-10B	1991		1	Precambrian							
MW-11	1990	Dry	1	Precambrian							
SB-16	1991	✓	✓	Precambrian							
Tracer-5	1997		1	Fisher Mtn. Instrusive							
			Miller	Creek Area							
MW-5A	1989		✓	Alluvium							
MW-5P	1989	✓	1	Wolsey Shale							
			Daisy	Creek Area							
MW-3	1989		✓	Wolsey Shale							

Note: **✓**- sampled

-- - inaccessible due to snow conditions. Well locations shown on Figure 3.

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# 3.0 RESULTS

Pertinent surface water and groundwater data collected for the New World Mining District Response and Restoration Project during May, July, and September 1999 are summarized in this section. The complete database for 1999 results is presented in the Appendices.

### 3.1 SURFACE WATER

Laboratory analytical reports, chain of custody forms, and field notes for the 1999 surface water monitoring events are contained in appendix A. Included in Appendix A is Table A-1 summarizing all surface water monitoring data collected during 1999.

Tables 3 and 4 show 1999 surface water analytical results with corresponding regulatory standards for Daisy and Fisher creeks, respectively. The shading or color of the concentrations for each monitoring station indicates which regulatory standard the concentration exceeds (e.g. yellow shading indicates exceedance of the acute aquatic life standard).

Review of Table 3 shows aluminum, copper, and zinc exceeded acute and chronic aquatic standards at upstream stations DC-2 and DC-5 during all three 1999 sampling events. Copper was the only metal to exceed acute aquatic standards at downstream station SW-7 during May and July. Copper at upstream station DC-2 during May (low flow) was the only metal measured at a concentration above human health standards. All metals concentrations measured in samples collected from the three stations in 1999 were below both temporary and narrative water quality standards.

Review of Table 4 shows that water quality in Fisher Creek generally improves downstream, as none of the metals exceeded any water quality standards at downstream station CFY-2 during May 1999. However, aluminum and copper exceeded chronic aquatic life standards at station CFY-2 during July 1999 and copper exceeded the acute and chronic standard at station CFY-2 during September 1999. No temporary standards were exceeded at CFY-2. One exceedance of the narrative standard was exceeded at SW-3 for zinc on the May sampling date. The concentration of zinc measured at this station in May is the highest concentration measured at this station of the 51 samples collected since 1989. Based on metals loads calculated by URS (1998), water quality in Fisher Creek did not appear to improve as a result of reclamation work completed in Como Basin, as total annual metals loads in Fisher Creek during 1995/1996 were similar to those calculated for the 1974/1975 water year.

Selected flow, pH, and metals data collected at stations DC-2 and DC-5 are presented in Table 5. These data only represent fall data obtained on Daisy Creek during comparable low flow conditions. Review of Table 5 shows metals concentrations at both stations DC-2 and DC-5 dropped considerably during September 1999 as compared to previously collected data. The lower metals concentrations measured in Daisy Creek during September 1999 may be attributable to improved groundwater quality resulting from the McLaren Pit reclamation work. Crediting the lower metals concentrations measured in Daisy Creek during September 1999 to the 1993-1995 McLaren Pit reclamation work would suggest groundwater emanating from the McLaren Pit does not daylight to Daisy Creek for a period of approximately four years. Future low flow data collected on Daisy Creek will serve to support or refute this premise.

Review of Miller Creek results show that no regulatory standard was exceeded at station SW-2 in September 1999 (Table A-1). Station SW-5 results show aluminum and copper concentrations exceeded chronic aquatic life standards in the July 1999 event.

Review of Soda Butte Creek results indicate that only aluminum exceeded chronic aquatic life standards (Table A-1).

### 3.2 GROUNDWATER

Laboratory analytical reports, chain of custody forms, and field notes for the 1999 groundwater monitoring events are contained in Appendix B. Included in Appendix B is Table B-1 summarizing all groundwater monitoring data collected during 1999.

Tables 6 and 7 compare selected 1999 groundwater quality data to historical data for wells in the McLaren Pit area and Como Basin, respectively. Comparing the 1999 sample results to historic data, groundwater quality is generally within the historic range for each well.

Groundwater quality data for wells in the McLaren Pit area are summarized in Table 6. Review of these data show that, in general, groundwater intercepted by wells completed in waste rock is typically the most acidic, with average pH values ranging from 2.4 in well EPA-4 to 2.9 in well EPA-3. The average pH of water intercepted by wells screened in the Meagher Limestone ranged from 3.4 to 3.9, with the lowest pH occurring during July (high groundwater). The average pH of Wolsey Shale wells (EPA-1, EPA-9, and MW-2) ranges from 3.2 in well EPA-2 to 6.6 in well EPA-9. Fisher Mountain Intrusive wells (EPA-5 and EPA-6) intercept water with pH ranging from 3.4 to 5.5. The highest pH values occurred during May (low groundwater conditions). As expected, dissolved metals concentrations correlate inversely with pH values.

With the exception of well EPA-2 (completed in Fisher Mountain Intrusive and Wolsey Shale formations), dissolved metals concentrations in all McLaren Pit area wells decrease with depth. The highest concentrations of dissolved aluminum, copper, and zinc occur in well EPA-4, which is completed in waste rock. The highest dissolved iron concentrations occur in well EPA-10, completed in the Meagher Limestone.

Groundwater quality data for Como Basin area wells are summarized in Table 7. In general, groundwater in Como Basin is of better quality than groundwater in the McLaren Pit area. Dissolved metals concentrations are typically lower, pH values are more basic, and sulfate concentrations are lower. Like the McLaren Pit area, the quality of groundwater in Como Basin appears to be poorest during periods of high water levels (July) similar to the trend evident in the McLaren Pit area. However, groundwater has not been sampled in Como Basin as frequent as it has in the McLaren Pit area to definitively identify this trend.

Review of the data on Table 7 show that groundwater intercepted by wells EPA-12 and Tracer-6 (both completed in Scotch Bonnet diorite) is the best quality of that sampled in Como Basin. Average pH values of water sampled from EPA-12 and Tracer-6 range from 6.2 to 6.3 and concentrations of dissolved metals are considerably lower than metals concentrations in other Como Basin wells. Well MW-1, completed in the Wolsey Shale, has the lowest pH of any well in Como Basin.

# TABLE 3 COMPARISON OF SURFACE WATER RESULTS TO STANDARDS DAISY CREEK DRAINAGE SAMPLING STATIONS 1999 MONITORING EVENTS

Parameter	Aquatic Life	Aquatic Life	Human Health		DC-2			DC-5				
(mg/l)	(acute)	(chronic)	Standard	Narrative	May-99	Jul-99	Sep-99	Temporary	May-99	Jul-99	Sep-99	
				Water Quality Standard <sup>(1)</sup>				Water Quality Standard <sup>(2)</sup>				
Aluminum	0.75	0.087	NA	28.4	9.2	3.7	12.4	9.510	1.4	1.2	4.0	
Cadmium	0.002067 <sup>(3)</sup>	0.001429 <sup>(3)</sup>	0.005	0.009	0.0038	0.0012	0.0044	0.004	0.0006	0.0004	0.0012	
Copper	0.0073 <sup>(3)</sup>	0.00529 <sup>(3)</sup>	1.3	8.064	1.94	1.07	3.98	3.530	0.33	0.31	1.26	
Iron	NA	1	NA	29.649	16	4.83	13.6	6.830	0.65	1.54	2.67	
Lead	0.082 <sup>(4)</sup>	0.0032(4)	15	0.018	0.006	0.002	0.002	NA	0.001	0.001	0.002	
Manganese	NA	NA	NA	4.088	1.61	0.37	1.93	1.710	0.25	0.124	0.50	
Zinc	0.067 <sup>(3)</sup>	0.067 <sup>(3)</sup>	2.1	1.104	0.51	0.15	0.60	0.540	0.08	0.07	0.17	
pH (s.u.)	NA	NA	NA	2.7	4.5	5.2	3.8	4.6	7.6	7.7	7.5	
Flow (cfs)	NA	NA	NA	NA	0.028	9.46	0.46	NA	1.18	23.82	1.48	

Parameter	Aquatic Life	Aquatic Life	Human Health		SW-7	•	
(mg/l)	(acute)	(chronic)	Standard	Temporary	May-99	Jul-99	Sep-99
				Water Quality Standard <sup>(2)</sup>			
Aluminum	0.75	0.087	NA	0.670	0.4	0.4	<0.1
Cadmium	0.002067 <sup>(3)</sup>	0.001429 <sup>(3)</sup>	0.005	NA	<0.0001	0.0001	<0.0001
Copper	0.0073 <sup>(3)</sup>	0.00529 <sup>(3)</sup>	1.3	0.200	0.008	0.064	<0.001
Iron	NA	1	NA	1.320	0.62	0.53	0.42
Lead	0.082 <sup>(4)</sup>	0.0032(4)	15	0.013	<0.001	<0.001	<0.001
Manganese	NA	NA	NA	0.086	0.036	0.027	0.023
Zinc	0.067 <sup>(3)</sup>	0.067 <sup>(3)</sup>	2.1	0.049	<0.01	0.02	0.03
pH (s.u.)	NA	NA	NA	5.5	7.1	7.9	7.5
Flow (cfs)	NA	NA	NA	NA	6.48	111.83	2.49

#### NOTES:

Shading/coloring indicates exceedance of respectively shaded/colored regulatory standard

\* All metals are reported as Total Recoverable Metals

mg/l Milligrams per liter (s.u.) Standard unit (cfs) Cubic feet per second

Indicates analyte not detected above laboratory Practical Quantitation Limit (PQL)

(1) Narrative Water Quality Standards apply to any point in affected stream segments. Like the Temporary Water Quality Standards, the

Narrative Water Quality Standards are a calculated as the mean concentration plus two (2) standard deviations.

(2) Temporary Water Quality Standards are set in accordance to the rule adopted by the Board of Environmental Review.

These standards apply to specific surface water sampling stations and shall not be exceeded more than 3% of the time.

(3) Based on 50 mg/l hardness

(4) Based on 100 mg/l hardness

Table 3 back page

# TABLE 4 COMPARISON OF SURFACE WATER RESULTS TO STANDARDS FISHER CREEK DRAINAGE SAMPLING STATIONS 1999 MONITORING EVENTS

Parameter	Aquatic Life	Aquatic Life	Human Health		SW-3			SW-4				
(mg/l)	(acute)	(chronic)	Standard	Narrative	May-99	Jul-99	Sep-99	Narrative	May-99	Jul-99	Sep-99	
				Water Quality Standard <sup>(1)</sup>				Water Quality Standard <sup>(1)</sup>				
Aluminum	0.75	0.087	NA	4.54	3.9	1.5	3.1	0.740	<0.1	0.3	<0.1	
Cadmium	0.002067 <sup>(3)</sup>	0.001429 <sup>(3)</sup>	0.005	0.002	0.0011	0.0002	0.0005	0.001	0.0004	0.0001	0.0003	
Copper	0.0073 <sup>(3)</sup>	0.00529 <sup>(3)</sup>	1.3	1.256	0.90	0.41	1.00	0.172	0.06	80.0	0.07	
Iron	NA	1	NA	9.259	7.49	1.85	7.03	1.726	0.03	0.29	0.03	
Lead	0.082 <sup>(4)</sup>	$0.0032^{(4)}$	15	0.01	0.007	0.002	0.002	0.005	<0.001	<0.001	<0.001	
Manganese	NA	NA	NA	1.718	1.35	0.162	1.30	0.790	0.021	0.027	0.072	
Zinc	0.067 <sup>(3)</sup>	0.067 <sup>(3)</sup>	2.1	0.225	0.29	0.06	0.18	0.660	0.05	0.03	0.06	
pH (s.u.)	NA	NA	NA	2.1	3.4	4.2	3.3	5.241	6.7	7.1	7.1	
Flow (cfs)	NA	NA	NA	NA	0.22	7.53	0.31	NA	0.42	45.706	1.46	

Parameter	Aquatic Life	Aquatic Life	Human Health		CFY-2	2		SW-6				
(mg/l)	(acute)	(chronic)	Standard	Temporary	May-99	Jul-99	Sep-99	Narrative	May-99	Jul-99	Sep-99	
				Water Quality Standard <sup>(2)</sup>				Water Quality Standard <sup>(1)</sup>				
				Standard				Standard				
Aluminum	0.75	0.087	NA	0.470	<0.1	0.2	<0.1	0.763	0.1	0.2	<0.1	
Cadmium	0.002067 <sup>(3)</sup>	0.001429 <sup>(3)</sup>	0.005	NA	<0.0001	0.0001	0.0002	0.03472	<0.0001	<0.0001	<0.0001	
Copper	0.0073 <sup>(3)</sup>	0.00529 <sup>(3)</sup>	1.3	0.110	0.004	0.09	0.022	0.076	0.01	0.034	0.016	
Iron	NA	1	NA	0.750	<0.01	0.23	0.04	1.132	0.13	0.27	0.04	
Lead	0.082 <sup>(4)</sup>	0.0032 <sup>(4)</sup>	15	0.002	<0.001	<0.001	<0.001	ND	<0.001	<0.001	< 0.001	
Manganese	NA	NA	NA	0.082	< 0.005	0.019	0.017	0.03415	0.008	0.014	0.017	
Zinc	0.067 <sup>(3)</sup>	0.067 <sup>(3)</sup>	2.1	0.044	<0.01	0.04	0.04	0.11032	<0.01	0.02	0.02	
pH (s.u.)	NA	NA	NA	5.7	7.1	7.2	6.9	5.7	7.3	7.6	7	
Flow (cfs)	NA	NA	NA	NA	0.09	21.46	2.07	NA	0.09	21.46	2.07	

#### NOTES:

Shading/coloring indicates exceedance of respectively shaded/colored regulatory standard

All metals are reported as Total Recoverable Metals

mg/l Milligrams per liter (s.u.) Standard unit (cfs) Cubic feet per second

< Indicates analyte not detected above laboratory Practical Quantitation Limit (PQL)

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(3) Based on 50 mg/l hardness

(4) Based on 100 mg/l hardness

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# **TABLE 5** SELECTED METALS DATA FOR DAISY CREEK **FALL LOW FLOW SAMPLE EVENTS**

	DC-2													
Date	Flow	рН	Aluminum	Copper	Iron	Manganese	Zinc							
10/89	0.20	2.90	N.M.	7.89	28.26	3.37	1.03							
9/94	N.M.	N.M.	25.00	7.44	23.6	3.59	1.20							
9/95	0.19	3.30	22.00	6.33	16.2	2.99	0.89							
9/96	0.18	3.10	20.20	6.22	15.6	2.72	0.89							
9/99 0.46		3.8	12.4	3.98 13.6		1.93	0.6							
			D	C-5										
10/89	0.37	5.20	N.M.	2.54	6.88	1.16	0.4							
9/93	0.54	5.80	5.3	2.17	4.68	1.2	0.36							
8/94	0.24	5.60	8.10	2.85	5.7	1.23	0.42							
9/95	0.42	5.40	7.70	2.45	2.38	1.18	0.39							
9/96	0.31	5.40	7.20	2.62	4.42	1.08	0.37							
9/99	1.48	7.5	4.00	1.26	2.67	0.5	0.17							

Notes: Flow in cubic feet per second.

Metals are total recoverable metals in mg/l.

TABLE 6 McLaren Pit Area 1999 Groundwater Monitoring Comparison

					Laboratory	Parameters						
Sample	Sample				D	issolved Meta	ıls					
Location	Date	pН	Aluminum	Cadmium	Copper	Iron	Lead	Manganese	Zinc			
		(Ś.U)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)			
		, ,	,	Waste F		,	,		, ,			
EPA-3	07/28/99	2.7	31.00	0.0036	12.600	135.0	0.006	1.31	0.73			
EPA-3	MAX*	3.0	31.20	0.0084	13.600	140.0	0.015	2.50	1.26			
EPA-3	MIN*	2.7	0.52	0.0020	0.007	0.0	0.002	0.06	0.03			
EPA-3	MEAN*	2.9	20.91	0.0047	8.736	91.7	0.008	1.29	0.67			
EPA-4	07/28/99	2.4	97	0.0220	41.000	383.0	< 0.001	10.00	4.14			
EPA-4	MAX*	2.4	111	0.0310	44.400	439.0	0.015	10.60	4.14			
EPA-4	MIN*	2.3	81.7	0.0220	34.500	197.0	0.001	9.31	3.41			
EPA-4	MEAN*	2.4	92.6	0.0252	38.600	329.6	0.005	9.86	3.78			
EPA-7	07/09/97		20.3	< 0.0050	1.240	5.90	< 0.003	J 0.155	0.09			
EPA-7	05/11/99		•		D	ry	•	•				
EPA-7	07/27/99		Not Sampled									
			F	isher Mounta								
EPA-5	07/29/99	3.6	65.0	0.0010	10.200	71.8	0.003	0.48	0.23			
EPA-5	MAX*	3.6	72.8	0.0050	11.900	78.7	0.003	0.54	0.23			
EPA-5	MIN*	3.5	63.7	0.0010	2.750	70.7	0.002	0.48	0.18			
EPA-5	MEAN*	3.6	66.3	0.0023	6.973	75.0	0.003	0.52	0.20			
EPA-6	05/11/99	3.8	49.9	0.0010	0.400	64.4	0.002	0.58	0.21			
EPA-6X	05/11/99	3.8	51.9	0.0009	0.430	67.6	0.001	0.61	0.22			
EPA-6	07/27/99	3.6	45.0	0.0008	0.800	57.6	0.001	0.48	0.22			
EPA-6X	07/27/99	3.6	45.0	0.0008	0.780	57.5	0.002	0.48	0.20			
EPA-6	MAX*	5.5	64.0	0.0200	6.090	69.5	0.006	0.74	0.22			
EPA-6	MIN*	3.4	45.0	0.0001	0.001	0.0	0.001	0.01	0.01			
EPA-6	MEAN*	4.1	40.0	0.0031	1.824	46.9	0.002	0.43	0.16			
				Meagher Li	mestone							
EPA-8	05/10/99	4.1	26.1	0.0250	16.000	43.8	0.008	12.80	2.48			
EPA-8	07/28/99	3.6	59.0	0.0380	33.500	72.4	0.003	11.30	3.02			
EPA-8	MAX*	4.2	69.4	0.0380	40.400	94.0	0.030	13.00	3.20			
EPA-8	MIN*	3.5	26.1	0.0225	16.000	43.8	0.003	11.30	2.48			
EPA-8	MEAN*	3.9	52.5	0.0264	29.967	72.8	0.011	12.25	2.90			
EPA-10	05/12/99	3.7	25.7	0.0140	5.000	237.0	0.012	5.41	1.97			
EPA-10	07/28/99	3.2	59.0	0.0180	25.800	357.0	0.009	8.43	3.28			
EPA-10	MAX*	3.7	72.9	0.0448	34.800	448.0	0.046	11.90	3.77			
EPA-10	MIN*	3	25.7	0.0140	5.000	237.0	0.009	5.41	1.97			
EPA-10	MEAN*	3.4	52.6	0.0242	22.317	356.3	0.026	8.61	3.08			

TABLE 6 (Continued)
McLaren Pit Area
1999 Groundwater Monitoring Comparison

					Laboratory	Parameters			
Sample	Sample				Ĺ	Dissolved Meta	ls		
Location	Date	pН	Aluminum	Cadmium	Copper	Iron	Lead	Manganese	Zinc
		(S.U)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
				Wolsey	Shale				
EPA-1	05/10/99	4.7	11.9	0.0080	0.180	163.0	0.050	5.13	
EPA-1	07/27/99	4.5	14	0.0094	0.740	239.0	0.044	6.92	2.26
EPA-1	MAX*	4.7	18.5	0.0250	2.230	449.0	0.112	11.70	3.16
EPA-1	MIN*	4.1	11.9	0.0080	0.180	163.0	0.044	5.13	1.78
EPA-1	MEAN*	4.5	15.6	0.0126	0.786	236.8	0.076	6.74	2.35
EPA-2	07/28/99	3.8	38	0.0074	1.440	153.0	0.072	2.86	1.20
EPA-2	MAX*	3.8	57.1	0.0223	23.500	292.0	0.204	5.36	3.71
EPA-2	MIN*	2.8	19.7	0.0056	1.440	129.0	0.020	2.68	1.17
EPA-2	MEAN*	3.2	34.38	0.0123	10.088	178.0	0.079	3.77	2.20
EPA-9	05/10/99	6.8	< 0.1	0.0004	< 0.001	41.5	< 0.001	1.31	0.17
EPA-9	07/28/99	6.6	< 0.1	< 0.0001	0.003	32.9	< 0.001	1.02	0.17
EPA-9	MAX*	6.8	0.2	0.0050	0.010	48.0	0.003	1.49	0.19
EPA-9	MIN*	6.3	0.0	0.0001	0.001	21.9	0.001	0.90	0.05
EPA-9	MEAN*	6.6	0.1	0.0013	0.004	34.8	0.002	1.16	0.14
MW-2	05/12/99	3.9	34.4	0.0017	0.011	92.2	0.008	1.09	0.24
MW-2	07/27/99	3.7	36.0	0.0012	0.011	94.5	0.004	1.04	0.31
MW-2	MAX*	4	51.0	0.0060	0.910	131.0	0.030	1.20	0.91
MW-2	MIN*	2.8	34.4	0.0006	0.010	23.0	0.002	0.62	0.24
MW-2	MEAN*	3.5	42.8	0.0026	0.348	100.8	0.013	0.99	0.48

Note:

<sup>\*</sup> Max, Min, and Mean are calculated using entire hisorical data for each sample location presented

TABLE 7 Como Basin 1999 Groundwater Monitoring Comparison

		Laboratory Parameters							
Sample	Sample	Dissolved Metals							
Location	Date	Нq	Aluminum	Cadmium	Copper	Iron	Lead	Manganese	Zinc
		(S.U)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
Fisher Mountain Intrusive									
EPA-11	07/27/99	3.6	5.2	0.0093	0.530	307.00	0.320	15.300	1.41
EPA-11	MAX*	4.3	5.2	0.0250	0.530	348.00	0.320	15.300	1.41
EPA-11	MIN*	3.6	1.0	0.0058	0.042	294.00	0.003	10.800	0.92
EPA-11	MEAN*	4.0	2.3	0.0148	0.202	314.60	0.147	12.820	1.23
TRACER-4	07/29/99	3.7	0.8	0.0004	0.070	119.00	< 0.001	9.870	1.96
TRACER-4	MAX*	3.7	0.8	0.0050	0.070	119.00	0.010	9.870	1.96
TRACER-4	MIN*	3.7	0.3	0.0004	0.010	107.00	0.001	7.720	0.98
TRACER-4	MEAN*	3.7	0.6	0.0027	0.040	113.00	0.006	8.795	1.47
TRACER-5	07/26/99	3.6	25.1	0.0018	5.840	55.00	0.003	0.930	0.43
TRACER-5	MAX*	3.6	25.1	0.0018	5.840	55.00	0.010	0.930	0.43
TRACER-5	MIN*	3.6	21.7	0.0010	0.830	44.90	0.003	0.660	0.23
TRACER-5	MEAN*	3.6	23.4	0.0014	3.335	49.95	0.007	0.795	0.33
Wolsey Shale									
MW-1	07/27/99	3.3	1.4	0.0007	0.330	45.00	0.008		0.17
MW-1	MAX*	4.5	2.3	0.0050	2.580	85.60	0.092	6.760	0.52
MW-1	MIN*	3.3	0.1	0.0005	0.010	11.50	0.000	0.990	0.05
MW-1	MEAN*	3.7	1.2	0.0022	0.410	37.15	0.021	3.324	0.23
Scotch Bonnet Diorite									
EPA-12	05/11/99	6.2	< 0.1	< 0.0001	< 0.001	29.70	< 0.001	1.480	0.04
EPA-12	07/26/99	5.7	< 0.1	< 0.0001	< 0.001	27.30	< 0.001	1.450	0.07
EPA-12	MAX*	6.8	0.2	0.0050	0.010	30.50	0.003	1.860	0.07
EPA-12	MIN*	5.7	0.0	0.0001	0.001	9.22	0.001	1.170	0.01
EPA-12	MEAN*	6.3	0.1	0.0012	0.004	20.80	0.002	1.480	0.03
TRACER-6	07/27/99	6.2	0.4	0.0010	0.180	17.60	< 0.001	3.280	0.08
TRACER-6	MAX	6.2	0.4	0.0010	0.180	17.60	0.010	3.280	0.08
TRACER-6	MIN	6.2	0.1	0.0010	0.010	9.10	0.001	1.480	0.01
TRACER-6	MEAN	6.2	0.3	0.0010	0.095	13.35	0.006	2.380	0.05

Note:

<sup>\*</sup> Max, Min, and Mean are calculated using entire hisorical data for each sample location presented

# 4.0 DATA VALIDATION

This section describes the data validation process used to determine the adequacy and quality of laboratory analytical data collected for the New World Mining District Project during 1999. The objective of data validation is to identify any unreliable or invalid measurements and qualify that data for interpretive use. These validations were performed according to guidelines prepared by US EPA (1994).

### 4.1 SURFACE WATER VALIDATION

The May, July, and September 1999 surface water monitoring events were validated independently as separate sample matrices. Data qualifiers used to flag data are as follows: '<' indicates the material was analyzed for, but not detected above the level of the associated value practical quantitation limit (PQL); 'J' indicates the associated values are an estimated quantity; and, 'R' indicates the data are unacceptable.

### 4.1.1 FIELD QA/QC

During the May, July, and September 1999 sampling events, field duplicates were prepared and containerized by Maxim field personnel in accordance to the Site-Wide SAP (Maxim, 1999c). During the May 1999 sampling event, one duplicate sample was collected from well SBC-4 (RR-SBC-4X). During the July and September 1999 sampling event, duplicate samples were collected from monitoring station SW-4 (RR-SW-4X). No rinsate blanks were collected during surface water collection because all samples were collected with single use sampling equipment

Field duplicate results aid in the assessment of sampling and analytical accuracy. Analytical results for the original and duplicate samples collected from each sampling event were evaluated using RPD and absolute value difference. The RPD between the two samples was calculated when both values of the natural/duplicate pair were greater than five times the PQL for a given analyte. The absolute value difference between the natural and duplicate sample for a given analyte was calculated when one or both values were less than five times the PQL.

RPDs are calculated by dividing the difference between the two reported values for a given parameter by the average of the two parameters. Analytical results of parameters where the RPD was greater than 20 percent are considered estimated concentrations. No parameter exhibited an RPD greater than 20 percent in the May or July 1999 sample events. In the September sampling event, total recoverable zinc exhibited a RPD of 58.8 percent; therefore, September zinc data are considered estimated values and flagged using the J qualifier.

Results from natural/duplicate pairs with values less than five times the PQL are considered estimated when the absolute value difference exceeds the PQL. No parameter exhibited differences greater than the PQL in the May, July, and September 1999 sample events.

# 4.1.2 LABORATORY QA/QC

Northern Analytical Laboratories received groundwater samples from the New World Mining District on May 7, July 9, and September 30, 1999. All samples arrived at the laboratory cool (>1.0° C and <11° C) and all samples were analyzed within the required holding time for the parameters of interest.

Northern Analytical Laboratories' quality assurance coordinator reviewed calibration standards, calibration verification, laboratory controls, laboratory duplicates, and laboratory spikes on a daily basis. Review of these quality indicators showed that all inorganic analyses were in compliance with Northern's QA/QC criteria and within the precision and accuracy guidelines specified in Northern's *Laboratory Ouality Assurance Plan* (submitted to MDHES on June 1997).

Accuracy is measured as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy acceptance or rejection is based on the percent recovery (%R) of the laboratory matrix spike for water samples. To determine accuracy, the %R for each matrix spike is compared to the acceptable range as specified in the applicable laboratory method. Natural results associated with percent recoveries outside acceptable limits are considered estimated. Natural results associated with percent recoveries of less than 50% are considered rejected, as recommended by EPA (1988). An overall assessment of accuracy is made upon completion of the project. Overall accuracy is stated as the mean %R. Under this criterion, all surface water data collected in 1999 data are acceptable.

### 4.1.3 DATA COMPLETENESS

No data have been rejected on the basis of field QA/QC or laboratory QA/QC in any sampling event. Therefore, a data completeness of 100% has been achieved for the May, July, and September 1999 surface water monitoring events.

### 4.2 GROUNDWATER DATA VALIDATION

The May and July 1999 groundwater monitoring events were validated independently as separate sample matrices. Data flagging are the same as that used for surface water samples.

### 4.2.1 FIELD QA/QC

During the May and July 1999 sampling events, deionized water blanks, rinsate blanks, and field duplicates were prepared and containerized by Maxim field personnel in accordance with the Site-Wide SAP (Maxim, 1999c).

During the May 1999 sampling event, one duplicate sample was collected from well EPA-6 (RR-EPA-6X). One rinsate blank and one deionized water blank were also prepared and containerized by field technicians and labeled accordingly.

During the July 1999 sampling event, four duplicate samples were collected from wells EPA-5, EPA-6, EPA-10, and MW-1 and were labeled in accordance with the Site-Wide SAP. Rinsate and deionized water blanks were prepared by field technicians while collecting a sample from well TRACER-2, and were labeled RR-TRACER-2-R and RR-TRACER-2-B, respectively.

Field duplicate results aid in the assessment of sampling and analytical accuracy. Analytical results for the original and duplicate samples collected from each sampling event were evaluated using the RPD and absolute value difference. The RPD between the two samples was calculated when both values of the natural/duplicate pair were greater than five times the PQL for a given analyte. The absolute value difference between the natural and duplicate sample for a given analyte was calculated when one or both values were less than five times the POL.

RPDs are calculated by dividing the difference between the two reported values for a given parameter by the average of the two parameters. Analytical results of parameters where the RPD was greater than 20 percent are considered estimated concentrations. No parameter exhibited an RPD greater than 20 percent in the May 1999 sample event. In the July sampling event, total dissolved zinc exhibited a RPD of 26.6 percent; therefore, the July results are considered as estimated values and flagged with the J qualifier.

Results from natural/duplicate pairs with values less than five times the PQL are considered estimated when the absolute value difference exceeds the PQL. No parameter exhibited differences greater than the PQL in either the May or July 1999 sample event.

All blank results (rinsate blank and deionized water blank) for both sampling events were evaluated using the following criteria to determine if any parameter was measured in the samples at detectable concentrations. The blank with the highest detectable concentrations was used for further evaluation in instances where more than one type of blank was contaminated. All results greater than or equal to the PQL but less than five times the concentration of the contaminated blank are considered estimated and are likely biased towards the high end. Neither the rinsate nor the deionized blanks were contaminated during the 1999 May or July sampling events.

### 4.2.2 LABORATORY OA/OC

Northern Analytical Laboratories received groundwater samples from the New World Mining District on May 14 and July 31, 1999. All samples arrived at the laboratory cool (>1.0° C and <10° C) and all samples were analyzed within the required holding time for the parameters of interest.

Northern Analytical Laboratories' quality assurance coordinator reviewed calibration standards, calibration verification, laboratory controls, laboratory duplicates, and laboratory spikes on a daily basis. Review of these quality indicators showed that all inorganic analyses were in compliance with Northern's QA/QC criteria and within the precision and accuracy guidelines specified in Northern's *Laboratory Quality Assurance Plan* (submitted to MDHES on June 1997).

Accuracy is measured as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy acceptance or rejection is based on the percent recovery (%R) of the laboratory matrix spike for water samples. To determine accuracy, the %R for each matrix spike is compared to the acceptable range as specified in the applicable laboratory method. Natural results associated with percent recoveries outside acceptable limits will be considered estimated. Natural results associated with percent recoveries of less than 50% will be considered rejected, as recommended by EPA (1988). An overall assessment of accuracy will be made upon completion of the project. Overall accuracy will be stated as the mean %R. All of the May 1999 data is acceptable. The July 1999 event had a low matrix spike recovery for lead at 36%. All samples associated with this analytical batch were reanalyzed by the Method of Standard Additions and proved the low recovery had no effect on the sample batch.

# 4.2.3 DATA COMPLETENESS

No data have been rejected on the basis of field QA/QC or laboratory QA/QC in either sampling event. Therefore, a data completeness of 100% has been achieved for the May and July 1999 groundwater monitoring events.

# 5.0 REFERENCES CITED

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